

Northumbria Research Link

Citation: Lockley, Steve, Benghi, Claudio and Cerny, Martin (2017) Xbim.Essentials: a library for interoperable building information applications. The Journal of Open Source Software, 2 (20). p. 473. ISSN 2475-9066

Published by: UNSPECIFIED

URL: <http://dx.doi.org/10.21105/joss.00473> <<http://dx.doi.org/10.21105/joss.00473>>

This version was downloaded from Northumbria Research Link:
<http://nrl.northumbria.ac.uk/id/eprint/36681/>

Northumbria University has developed Northumbria Research Link (NRL) to enable users to access the University's research output. Copyright © and moral rights for items on NRL are retained by the individual author(s) and/or other copyright owners. Single copies of full items can be reproduced, displayed or performed, and given to third parties in any format or medium for personal research or study, educational, or not-for-profit purposes without prior permission or charge, provided the authors, title and full bibliographic details are given, as well as a hyperlink and/or URL to the original metadata page. The content must not be changed in any way. Full items must not be sold commercially in any format or medium without formal permission of the copyright holder. The full policy is available online: <http://nrl.northumbria.ac.uk/policies.html>

This document may differ from the final, published version of the research and has been made available online in accordance with publisher policies. To read and/or cite from the published version of the research, please visit the publisher's website (a subscription may be required.)



**Northumbria
University**
NEWCASTLE



UniversityLibrary

Xbim.Essentials: a library for interoperable building information applications

Steve Lockley¹, Claudio Benghi¹, and Martin Černý¹

DOI: [10.21105/joss.00473](https://doi.org/10.21105/joss.00473)

¹ Northumbria University

Software

- [Review](#) ↗
- [Repository](#) ↗
- [Archive](#) ↗

Submitted: 05 September 2017

Published: 07 December 2017

Licence

Authors of JOSS papers retain copyright and release the work under a Creative Commons Attribution 4.0 International License ([CC-BY](#)).

Summary

The Xbim.Essentials library offers data extraction, data transformation and data validation functions for Building Information Models (BIM); its robust and optimised implementation allows efficient operations on gigabyte-range files for researchers and practitioners interested in the built environment.

The library implements the complete object model of BuildingSMART's IFC schemas (2017) along with APIs for their management under the terms of the CDDL (Sun Microsystems 2005), which makes it also suitable for commercial research and development projects.

Relevant fields of research span from social sciences to construction engineering and applied mathematics on account of the breadth of domains covered in the over 800 classes of the schema across building lifecycles.

The project implements public APIs for:

- Federating, merging and splitting models and entities within models (non-trivial because of cyclic and bi-directional relationships defined in the schemas).
- Verification of data quality through EXPRESS WHERE clauses and metadata constraints.
- programmatic management of IFC properties and relations through Schema Metadata.
- Single point management of any IFC file, including XML, STEP21 and IFCZIP formats.

Architectural features of the solution include:

- Full access to the models through C# interfaces, allowing schema-agnostic data logic on any supported version.
- Disk-based and in-memory options to suit diverse workflow infrastructures.
- Log management for notification events where exceptions are not appropriate.

Additionally, the Xbim.IO.TableStore namespace supports similar APIs, when conceptually suitable, on BuildingSMART's COBie object model (buildingSMART 2013), extending the domain of relevance to construction operations and facility management.

Where appropriate, classes in the codebase are generated programmatically from the formal EXPRESS specification files (ISO 2013) ensuring full compliance with the standards.

Schemas currently implemented are: 'IFC2x3 Technical Corrigendum 1' (Model Support Group 2007), 'IFC4 Addendum 1' (Model Support Group 2015) and 'COBie MVD' (buildingSMART 2013).

The library has been developed over many years and has supported several research projects such as iCAT (2010), 4BIM (2012), Digital tool for Bim (2014), Decc-MR (2015a) and Tier2Tier (2015b).

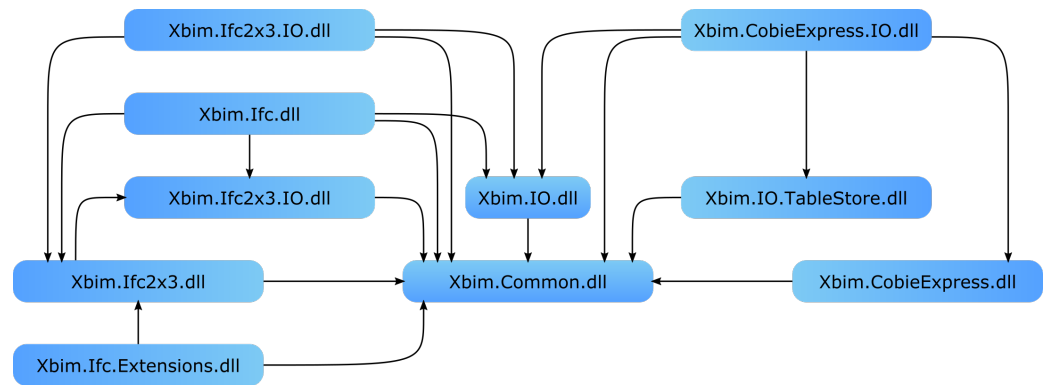


Figure 1: Internal DLL dependencies graph.

Xbim.Essentials also enabled the work of several scholars who, in absence of clear guidelines, have informally referenced its usage, such as Thomson and Boehm (2015), Porter (2014), Braun et al. (2017), Černý (2014), Weise et al. (2017) and Roupé et al. (2014).

The source code is written in C# and its repository is hosted on Github (xBimTeam 2017b), online documentation is available (xBimTeam 2017a) and compiled binaries can be installed via Nuget.org searching for “Xbim.Essentials”.

References

- Braun, A., A. Borrmann, S. Tutas, and U. Stilla. 2017. “Classification of Detection States in Construction Progress Monitoring.” In *eWork and eBusiness in Architecture, Engineering and Construction: ECPPM 2016*, 473. Limassol, Cyprus: CRC Press.
- buildingSMART. 2013. “COBie - Model View Definition.” October 30. http://docs.buildingsmartalliance.org/MVD_COBIE/.
- . 2017. “Summary of IFC Releases.” Technical Documentation. *buildingSMART-Tech.org*. <http://www.buildingsmart-tech.org/specifications/ifc-releases/summary>.
- Černý, Martin. 2014. “GIS Analýzy V Prostředí Informačních Modelů Staveb.” *Brno University of Technology, Faculty of Civil Engineering, Institute of Geodesy*. <https://dspace.vutbr.cz/bitstream/handle/11012/36237/22440.pdf?sequence=2>.
- InnovateUK. 2010. “Interoperable Carbon Assessment Toolkit (iCAT).” March. <http://gtr.rcuk.ac.uk/projects?ref=400144>.
- . 2012. “4BIM.” February. <http://gtr.rcuk.ac.uk/projects?ref=101150>.
- . 2014. “A Digital Tool for Building Information Modelling.” October. <http://gtr.rcuk.ac.uk/projects?ref=972199>.
- . 2015a. “DECC-MR Digital Engineering for Customised Compliance in Maintenance Regimes.” April. <http://gtr.rcuk.ac.uk/projects?ref=102062>.
- . 2015b. “Tier2Tier A Collaboration Interface Between Construction Main Contractors and Their Supply Chain Specialist Sub-Contractors.” April. <http://gtr.rcuk.ac.uk/projects?ref=102053>.
- ISO. 2013. “ISO-10303-11:2004 Industrial Automation Systems and Integration – Product Data Representation and Exchange – Part 11: Description Methods: The EXPRESS Language Reference Manual.” International Organization for Standardization. <https://www.iso.org/standard/54548.html>.

[//www.iso.org/standard/38047.html](http://www.iso.org/standard/38047.html).

Model Support Group. 2007. “IFC2x3 Technical Corrigendum 1 - Final Documentation.” <http://www.buildingsmart-tech.org/ifc/IFC2x3/TC1/html/index.htm>.

———. 2015. “IFC4 Addendum 1 - Final Documentation.” <http://www.buildingsmart-tech.org/ifc/IFC4/Add1/html/>.

Porter, Stuart Ross. 2014. “Breaking into BIM Physical Security Simulation Utilising Building Information Models.” M.Phil., Perth: Curtin University. <https://espace.curtin.edu.au/handle/20.500.11937/963>.

Roupé, Mattias, Mikael Viklund Tallgren, Mikael Johansson, and Roger Andersson. 2014. “Virtuell Produktionsplanering Med BIM Och Visualisering.” Chalmers University of Technology. <http://publications.lib.chalmers.se/publication/205896-virtuell-produktionsplanering-med-bim-och-visualisering>.

Sun Microsystems. 2005. “Common Development and Distribution License 1.0.” Open Source Initiative. <https://opensource.org/licenses/CDDL-1.0>.

Thomson, Charles, and Jan Boehm. 2015. “Automatic Geometry Generation from Point Clouds for BIM.” *Remote Sensing* 7 (9): 11753–75. doi:[10.3390/rs70911753](https://doi.org/10.3390/rs70911753).

Weise, Matthias, Thomas Liebich, Nicholas Nisbet, and Claudio Benghi. 2017. “IFC Model Checking Based on mvdXML 1.1.” In *eWork and eBusiness in Architecture, Engineering and Construction: ECPPM 2016*, 19–26. Limassol, Cyprus: CRC Press.

xBimTeam. 2017a. “xBIM Toolkit Documentation.” *Xbim Toolkit Documentation*. <http://docs.xbim.net/>.

———. 2017b. “XbimEssentials Source Code Repository.” August 18. <https://github.com/xBimTeam/XbimEssentials>.